

Applic. No.: 10/695,367

Amdt. Dated May 24, 2006

Reply to Office action of March 28, 2006

REMARKS/ARGUMENTS

Reconsideration of the application is requested.

Claims 1-13 remain in the application. Claim 1 has been amended.

In item 1 on page 2 of the above-mentioned Office action, claims 1-2 and 7-11 have been rejected as being anticipated by Xiao et al. (Energy Conversion & Management, January 2002, (43), pages 103-108)) under 35 U.S.C. § 102(b).

In item 2 on page 3 of the above-mentioned Office action, claims 1 and 6-7 have been rejected as being anticipated by Neuschutz et al. (US 2002/0060063 A1 - hereinafter "Neuschutz I") under 35 U.S.C. § 102(b).

In item 1 on page 4 of the above-mentioned Office action, claim 3 has been rejected as being unpatentable over Xiao et al. in view of Neuschutz et al. (US 2002/0033247 A1 - hereinafter "Neuschutz II") under 35 U.S.C. § 103(a).

In item 2 on page 4 of the above-mentioned Office action, claim 3 has been rejected as being unpatentable over Neuschutz I in view of Neuschutz II under 35 U.S.C. § 103(a).

Applic. No.: 10/695,367  
Amdt. Dated May 24, 2006  
Reply to Office action of March 28, 2006

In item 3 on page 5 of the above-mentioned Office action, claim 5 has been rejected as being unpatentable over Neuschutz I under 35 U.S.C. § 103(a).

In item 4 on page 5 of the above-mentioned Office action, claims 5-6 and 12-13 have been rejected as being unpatentable over Xiao et al. under 35 U.S.C. § 103(a).

As will be explained below, it is believed that the claims were patentable over the cited art in their original form and the claims have, therefore, not been amended to overcome the references. However, the language of claim 1 has been modified in an effort to even more clearly define the invention of the instant application.

Before discussing the prior art in detail, it is believed that a brief review of the invention as claimed, would be helpful.

Claim 1 calls for:

A material mixture, comprising: an amount of a phase change material and an amount of particulate expanded graphite mixed with said phase change material, the material mixture having no additional shape-stabilizing agent.

Applic. No.: 10/695,367  
Amdt. Dated May 24, 2006  
Reply to Office action of March 28, 2006

S102 rejection by Xiao et al.

Xiao et al. disclose a mixture including (i) expanded graphite, (ii) a phase change material PCM in the form of paraffin, and (iii) a styrene-butadiene-styrene (SBS) copolymer. The function of the SBS is to support (shape-stabilize) the paraffin, thus avoiding leakage when the paraffin is in the liquid state (see the last paragraph on page 105). This is a serious problem with solid-liquid PCMs (see the first paragraph on page 104). Therefore, the shape-stabilizer SBS is a mandatory constituent in Xiao et al.'s mixture.

The mixture according to claim 1 of the instant application does not contain a shape-stabilizer like SBS. Although the wording of original claim 1 does not explicitly exclude a shape stabilizer, it can be deduced from the specification that the invention of the instant application relates to latent heat storage mixtures including expanded graphite and PCM without any added shape stabilizer. It was found by the inventors of the invention of the instant application that due to the porosity of the surface of the expanded graphite particles the phase change material is held in those pores even after transition into the liquid state, thus avoiding escape (leakage) of the PCM from the heat store (see page 11,

Applic. No.: 10/695,367  
Amdt. Dated May 24, 2006  
Reply to Office action of March 28, 2006

lines 18-22 of the specification). This means that no additional shape stabilizer is needed.

The language of claim 1 of the instant application has been amended in an effort to even more clearly define the invention of the instant application. More specifically, claim 1 has been amended in such a way that any additional shape-stabilizing agent is excluded.

Claim 2 of the instant application is also not anticipated by Xiao et al. The mixtures disclosed by Xiao et al. contain 80 parts by weight of PCM, 20 parts by weight of SBS and only 3 or 5 parts by weight of expanded graphite. Recalculating this composition into weight percents, the SBS fraction amounts to more than 19 wt% of the mixture. The SBS does neither contribute to the heat storage nor to the thermal conductivity. Any addition of other components than PCM reduces the heat storage capacitance. Since there is already a large fraction of SBS, only a rather small fraction of expanded graphite (below 5 wt%) can be added, otherwise the heat storage capacitance would decrease too much. In turn, due to the small amount of expanded graphite Xiao et al. can achieve only a limited improvement of thermal conductivity.

Applic. No.: 10/695,367  
Amdt. Dated May 24, 2006  
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In the invention of the instant application, omission of shape-stabilizing agents, which do not contribute to the thermal conductivity, allows for an increased fraction of the thermally conductive graphite. Indeed, a graphite content above 5 % by volume is allowed. This results in a high thermal conductivity (see examples 1 and 3 in the specification).

In contrast to Xiao et al., who use weight-related composition data, in claim 2 of the instant application the volume fraction of expanded graphite is given. But it can be easily assessed that the weight fraction of graphite in Xiao et al.'s mixture is below the lower limit of claim 2. The apparent density of the expanded graphite is close to the theoretical density of graphite ( $2.25 \text{ g/cm}^3$ ). The densities of the other components of Xiao et al.'s mixture, paraffin and SBS, are around  $1 \text{ g/cm}^3$ , i.e. well below the density of the graphite. When recalculating from weight% into volume%, the value of the graphite fraction, due to its higher density, will be reduced, thus ending up with a value well below 5 % by volume. Thus, in the mixture with a composition according to claim 2 of the instant application, the graphite fraction is higher than that in Xiao et al.'s mixtures.

Applic. No.: 10/695,367  
Amdt. Dated May 24, 2006  
Reply to Office action of March 28, 2006

§102 Rejection by Neuschutz I

Neuschutz I discloses process for making a composite including a matrix of compressed expanded graphite and a phase change material introduced into this matrix by impregnation (see paragraphs [0001] and [0006]). Indeed, this teaching is very close to the prior art described on page 3, lines 4-11 and page 3, line 19 to page 4, line 2 of the specification.

Accordingly, it has the same drawbacks as lined out on page 4, lines 4-20 of the specification, which have to be overcome by the invention of the instant application. This is achieved by providing the expanded graphite in particulate form instead of a compressed matrix (see page 6, lines 21 to page 7, line 3 of the specification of the instant application). The graphite particles are mixed with the phase change material, thus avoiding the drawback related to the prior art impregnation process.

To further substantiate the difference between "a graphite matrix" and "graphite in particulate form," an excerpt from a textbook on composite technology, entitled "Composite Material: Engineering and Science," is attached. Matrix is defined therein as being continuous. This is a significant difference to the invention of the instant application, where the graphite is provided in the form of individual particles.

Applic. No.: 10/695,367  
Amdt. Dated May 24, 2006  
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Therefore, claim 1 and all claims depending on claim are believed to be patentable over Neuschutz I.

Rejection of claim 3 over Xiao et al. and Neuschutz II

It is true that Neuschutz II discloses the addition of nucleating agents to phase change materials. However, a combination of Xiao et al. and Neuschutz II does not lead to the mixture of claim 3 of the instant application due to the following reasons:

- (i) In Xiao et al.'s mixture the shape-stabilizing agent is a mandatory constituent, while the mixture of the invention of the instant application does not have a shape-stabilizing agent.
- (ii) Neuschutz II does not disclose expanded graphite as the heat-conducting auxiliary, but only graphite in general (see paragraphs [0038] and [0041]), thus teaching away from the invention of the instant application. The difference between expanded graphite and other kinds of graphite is indeed significant (see page 10, line 10 to page 11, line 22, example 1 and comparative example of the specification). Thus the selection of expanded graphite has a significant effect and should be



Applic. No.: 10/695,367  
Amdt. Dated May 24, 2006  
Reply to Office action of March 28, 2006

inventive over the combination of Xiao et al. and  
Neuschutz II.

Rejection of claim 3 over Neuschutz I and Neuschutz II

It is true that Neuschutz II discloses the addition of nucleating agents to phase change materials. However, a combination of Neuschutz I and Neuschutz II does not lead to the mixture of claim 3 of the instant application for the following reasons:

- (i) Neuschutz I teaches impregnation of the PCM into a continuous matrix from expanded graphite instead of the addition of particulate expanded graphite, thus teaching away from the invention of the instant application; and
- (ii) Neuschutz II does not disclose expanded graphite as the heat conducting auxiliary, but only graphite in general (see paragraphs [0038] and [0041]), thus teaching away from the invention of the instant application. The difference between expanded graphite and other kinds of graphite is indeed significant (see page 10, line 10 to page 11, line 22, example 1 and comparative example of the specification).



Applic. No.: 10/695,367

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Thus the selection of expanded graphite in particulate form has on one hand a significant effect over Neuschutz I, where a continuous matrix from expanded graphite is disclosed, and on the other hand over Neuschutz II, where graphite particles are disclosed, but not expanded graphite.

Therefore, claim 3 of the instant application is believed to be patentable over the combination of Neuschutz I and Neuschutz II.

Rejection of claim 5 over Neuschutz I

As discussed above, Neuschutz I does not disclose a mixture of a PCM and particulate expanded graphite as heat-conduction auxiliary. Indeed, only a continuous matrix is disclosed. So if particles are not disclosed in Neuschutz I, it is simply impossible that the size range of the particles claimed in the instant application could be obvious from Neuschutz I.

Furthermore, since Neuschutz I does not disclose particles at all, the combination of Neuschutz I with Timcal disclosing a specific particle size is not justified.

Applic. No.: 10/695,367  
Amdt. Dated May 24, 2006  
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Rejection of claims 5-6 and 12-13 over Xiao et al.

As discussed above, claim 1 is believed to be patentable over the art. Since claims 5-6 and 12-13 are ultimately dependent on claim 1, they are believed to be patentable as well.

In addition, it is noted that the reference Tamme ("workshop on Thermal Storage for Trough Power Systems") was issued in 2003, whereas the instant application has a priority date of October 28, 2002.

Applicants acknowledge the Examiner's statement in the section entitled "Allowable Subject Matter" on page 6 of the above-mentioned Office action that claim 4 would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

Since claim 1 is believed to be patentable as discussed above and claim 4 is ultimately dependent on claim 1, it is believed to be patentable in dependent form. A rewrite is therefore believed to be unnecessary at this time.

In view of the foregoing, reconsideration and allowance of claims 1-13 are solicited.

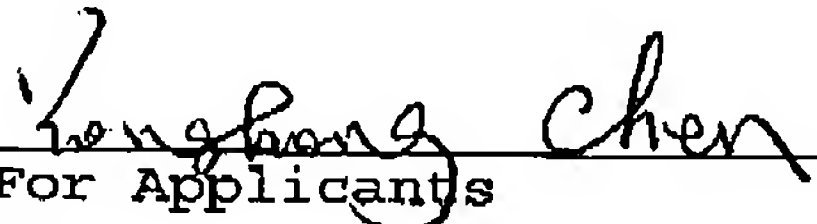
Applic. No.: 10/695,367  
Amdt. Dated May 24, 2006  
Reply to Office action of March 28, 2006

In the event the Examiner should still find any of the claims to be unpatentable, counsel would appreciate a telephone call so that, if possible, patentable language can be worked out.

If an extension of time for this paper is required, petition for extension is herewith made. Please charge any fees which might be due with respect to 37 CFR Sections 1.16 and 1.17 to the Deposit Account of Lerner Greenberg Stemer LLP, No. 12-1099.

Respectfully submitted,

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# Composite Materials: Engineering and Science

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# Contents

Preface	ix
1 Overview	1
1.1 Introduction	1
1.2 Definitions and classification	3
1.3 Natural composites	8
1.4 More about the matrix and reinforcement	10
1.5 Factors which determine properties	12
1.6 The benefits of composites	16
1.7 Summary	23
2 Reinforcements and the reinforcement-matrix interface	29
2.1 Introduction	29
2.2 Natural fibres	29
2.3 Introduction to synthetic fibres	32
2.4 Synthetic organic fibres	35
2.5 Synthetic inorganic fibres	39
2.6 Particulate and whisker reinforcements	55
2.7 Reinforcement-matrix interface	59
2.8 Summary	72
3 Composites with metallic matrices	78
3.1 Introduction	78
3.2 Metal matrix composite processing	79
3.3 Interface reactions	87
3.4 Properties of MMCs	91
3.5 Some commercial MMCs	94

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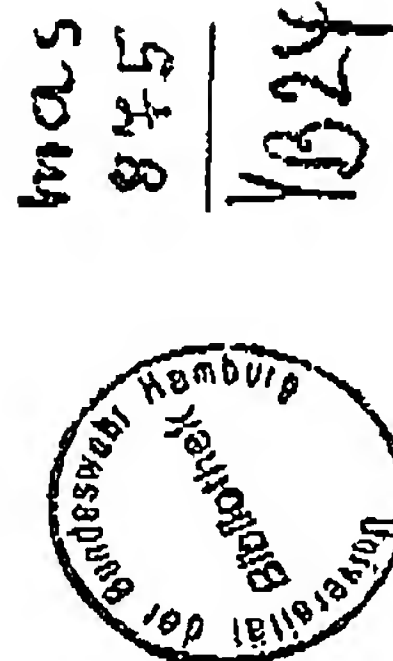
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industry. Similarly, the development of high strength silicon carbide, SiC, and alumina,  $Al_2O_3$ , fibres which maintain their properties at elevated temperatures initiated much of the current interest in composites based on metal and ceramics.

Composite materials can be studied from a number of different viewpoints each of which requires a different kind of expertise. Thus, the development of a composite material to resist a corrosive environment is primarily within the field of materials science and chemistry. In contrast the design of a load bearing structure requires the expertise of an engineer. It is therefore essential for the full exploitation of currently available composites, and for the future development of composites, that experts in one field are able to understand the problems of those in another. The study of composites is truly interdisciplinary and this will become increasingly clear as the reader proceeds through this book.

## 1.2 DEFINITIONS AND CLASSIFICATION

We have already stated that a composite is a mixture of two or more distinct constituents or phases. However this definition is not sufficient and three other criteria have to be satisfied before a material can be said to be a composite. First, both constituents have to be present in reasonable proportions, say greater than 5%. Secondly, it is only when the constituent phases have different properties, and hence the composite properties are noticeably different from the properties of the constituents, that we have come to recognize these materials as composites. For example plastics, although they generally contain small quantities of lubricants, ultra-violet absorbers, and other constituents for commercial reasons such as economy and ease of processing, do not satisfy either of these criteria and consequently are not classified as composites. Lastly, a man-made composite is usually produced by intimately mixing and combining the constituents by various means. Thus an alloy which has a two-phase microstructure which is produced during solidification from a homogeneous melt, or by a subsequent heat treatment whilst a solid, is not normally classified as a composite (Figure 1.2(a)). However if ceramic particles are somehow mixed with a metal to produce a material consisting of the metal containing a dispersion of the ceramic particles, then this is a true composite material (Figure 1.2(b)).

We know that composites have two (or more) chemically distinct phases on a microscopic scale, separated by a distinct interface, and it is important to be able to specify these constituents. The constituent that is continuous and is often but not always, present in the greater quantity in the composite is termed the *matrix*. The normal view is that it is the properties of the matrix that are improved on incorporating another constituent to produce a composite. A composite may have a ceramic, metallic or polymeric matrix.

